Apparatus for determining the deviation of a bore hole from the vertical axis

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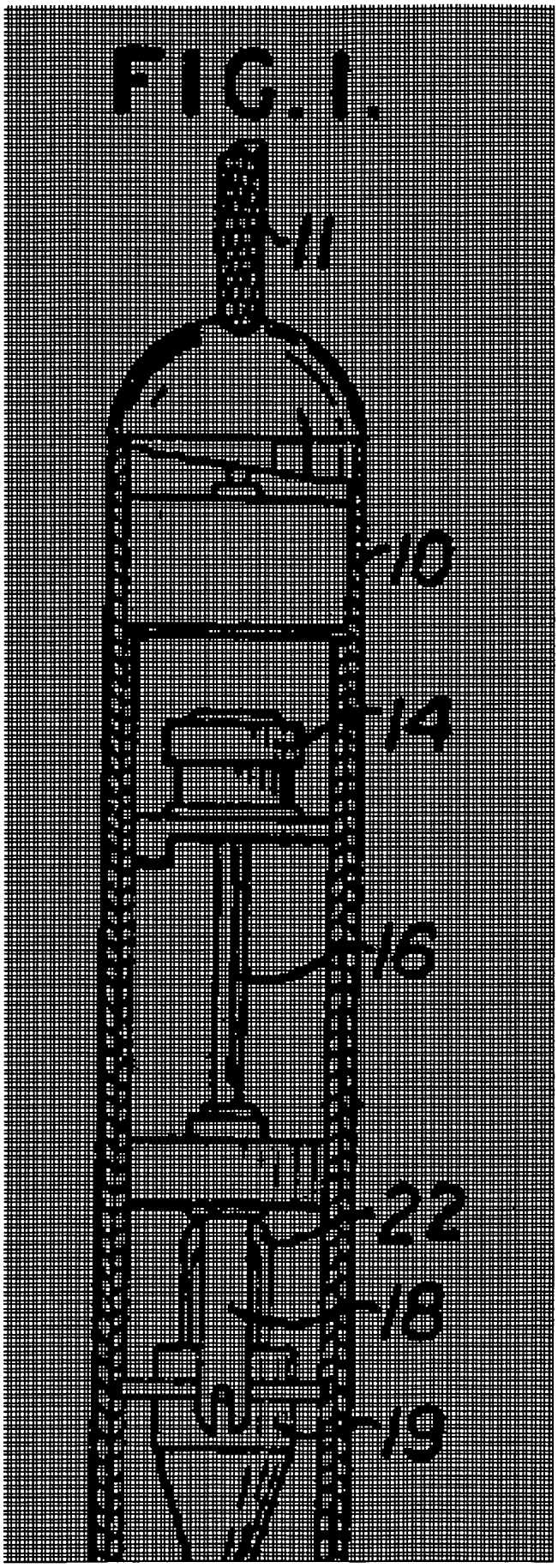
Abstract of **GB769495**

769,495. Bore-hole clinometers. SOC. DE PROSPECTION ELECTRIQUE PROCEDES SCHLUMBERGER. Aug. 10, 1954 [Aug. 29, 1953], No. 23263/54. Class 97(2) A bore-hole clinometer comprises a compass which is subjected to vibrations to prevent the needle sticking, a member pivotable about the longitudinal axis of the clinometer and carrying an off-centre weight, and a pendulum pivoted on said member, the compass, pivotable member and pendulum each being arranged to operate circuit control member which members are connected in a circuit so as to record or indicate the angles of the said members. As shown, the casing 10 contains a vibrator 14 which, via the rod 16, imparts weak vibrations to the compass suspension 18. The compass mount 19 is suspended to remain horizontal at all angles of the casing 10 and the rotation of the compass needle is communicated to the arm of a potentiometer 22 the resistance of which is proportional to the position of the compass needle. A cylinder 23 is suspended on pivots 26, 27 and one side is weighted by an elongated bar (not shown), which when the apparatus is not vertical, rotates the cylinder 23 so that the off-centre weight assumes the lowest position. This rotation is communicated to the arm of a potentiometer 29 whose resistance is thus a measure of the direction of the plane containing the bore-hole axis. A pendulum 31 is pivoted at 30 to swing in a plane through the axis 26-27 and the longitudinal axis of the off-centre weight. The movements of the pendulum are communicated by rack and pinion gears 32 to a potentiometer 34, the resistance of which is thus a measure of the deviation of the borehole from the vertical. The

potentiometers 23, 29 and 34 are connected into a circuit at the surface by leads 11, the circuit being arranged to operate recording or indicating instruments. Specification 644,466 is referred to.



PATENT SPECIFICATION

769,495

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Application made in France on August 29. 1953

Complete Specification Published: March 6, 1957

Index at acceptance:—Class 97(2), F1.

International Classification:—G01c.

COMPLETE SPECIFICATION

Apparatus for Determining the Deviation of a Bore Hole from the Vertical Axis

We, SOCIETE DE PROSPECTION ELECTRIQUE PROCEDES SCHLUMBERGER, of 42, rue Saint-Dominique, Paris VIIe, France, a Body-Corporate organised under the laws of the French Republic, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to apparatus providing indications, as a function of depth, of the deviation of wells with respect to the vertical. More specifically, it has to do with new and improved means providing indications at each point in the well of the angle which the well makes with the vertical and of the azimuth with respect to a specified geographical direction of reference of the vertical plane containing the axis of the well in such manner that, by making continuous measurements along the well, the course of the latter in the earth may be exactly determined.

Several different kinds of apparatuses have been proposed heretofore for measuring the deviation of wells. Certain of these apparatuses comprise in general a compass and an apparatus for measuring and indicating the angular direction of the well with respect to the vertical. These apparatuses often have the disadvantage of being relatively not very exact, principally because of inaccuracy and lack of sensitivity in the compass which does not point exactly to the north at each instant, and also from the fact that the apparatus for measuring the angular deviation of the well with respect to the vertical does not give indications that are precise, true and continuous.

The present invention aims at obviating the foregoing disadvantages and to this end consists in an apparatus for determining the deviation of a bore hole from the vertical axis and adapted to be moved inside said bore hole, which comprises a casing, compass means freely rotatably mounted in said casing for determining the position in azimuth of said casing with respect to a specified geographical direction, means for vibrating said compass means, a member freely pivotable about the longitudinal axis of said casing and carrying an off-centre weight adapted to cause said member to pivot about said axis in dependence upon the direction in azimuth of the deviation of the borehole, pendulum means on said member responsive to the angle of deviation of the bore hole from the vertical, and a circuit control member operatively connected to each of said compass means, said pivotable member and said pendulum means and responsive to movements of its associated element, each circuit control member being connectable in an electric circuit including indicating or recording instruments, preferably at the surface of the earth, responsive to variation of electrical magnitudes the value of which depends upon the angles of movement of said elements.

The compass means preferably comprise a small magnetic bar floating in a vessel in a cardan suspension and the vibrating means may conveniently comprise an eccentric device driven by an electric motor. It will thus be seen that the compass is prevented from jamming in any predetermined position and it is obliged consequently to point constantly in the direction of the magnetic north.

Conveniently, the circuit control members each comprise a potentiometer, responsive to movements of its associated member or element whereby to vary in amplitude in accordance with variations in the corresponding angles.

In order that the invention may be more readily understood, reference is made to the accompanying drawings, which represent schematically by way of non-limiting

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example a particular embodiment of the invention and in which:

Fig. 1 is a view, partially in longitudinal section, of bore hole deviation determining apparatus constructed according to the invention;

Fig. 2 is an enlarged view in longitudinal section of a compass device for use in the apparatus of Fig. 1:

Fig. 3 is an enlarged view in longitudinal section of the inclination measuring means employed in the apparatus of Fig. 1: and

Fig. 4 is a schematic diagram of a typical electrical circuit in which the apparatus of Fig. 1 may be connected to facilitate the recording of bore deviations as well as measurements of the azimuths of the deviations, according to the invention.

In Fig. 1, an elongated, pressure resistant housing or casing 10 is adapted to be passed down a bore hole by means of a conventional electrical cable 11. Housing 10 is constructed from a non-magnetic material so as not to disturb the magnetic compass indications made in accordance with the invention. The embodiment of the invention described hereinafter is particularly adapted to be employed in connection with dip measuring apparatus, as disclosed for example in British Patent No. 644,466. As such, housing 10 would include external centering and dip measuring means (not shown).

In the interior of housing 10 is a compass assembly 12 and an inclinometer assembly 13. As shown in Fig. 1, compass assembly 12 includes an electrical vibrator 14 mounted on a support 15 attached to housing 10. Vibrator 14 includes an electric motor driving an eccentric which bears on the end of and vibrates a drive shaft 16 passing through a support 17 to a compass suspension 18. Suspended from the compass suspension 18 is a compass mount 19 the suspension being of the universal type used in compass mounting to maintain the mount horizontal regardless of the angle that housing 10 makes with the vertical.

As shown in Fig. 2, in the interior of compass mount 19 is suspended a bar magnet 20, magnetized in order always to maintain one end thereof pointing in the direction of magnetic north. Bar magnet 20 is coupled by suspension means 21 to the movable arm of a potentiometer 22 electrically activated such that a continuous signal is obtained thereof proportional to the angular position bar magnet 20 assumes with compass suspension 18.

In the past it has not been practical to employ relatively low power compasses to drive potentiometers due to the fact that the potentiometric arm would tend to stick, thereby giving a false indication. However, due to the vibration imparted by vibrator 14 to compass suspension 18, the cyclic rate of which is high compared with the resonant frequency of the movable parts in compass mount 19 and the angular deviation of which is of the order of less than one degree, the potentiometer arm will not stick due to the dynamic reduction of friction by the vibrations. Further, the interior of compass mount 19 is filled with a liquid having a density approximately the same as that of bar magnet 20. Accordingly, any straight line vibrations imparted to compass mount 19, as for example by inadvertent shaking of housing 10, will not give false indications in the output of potentiometer 22.

As shown in Fig. 1, beneath compass assembly 12 is mounted an inclinometer assembly 13. The inclinometer assembly comprises a hollow cylinder 23 freely pivotable about the longitudinal axis of the housing on pivots 26 and 27 in supports 25 and 24 respectively mounted on the housing 10. Internally, the cylinder 23 carries an off-centre weight 28 which is adapted to cause the cylinder to pivot about the longitudinal axis of the housing in dependence upon the direction in azimuth of the deviation of a borehole. The side of the cylinder 23 defined by weight 28 will thus always lie along the lowermost portion of bore hole since the cylinder 23 may freely rotate. The angular position that the cylinder 23 makes with respect to a given point on housing 10, such as points determined by compass suspension 18 is translated into apropriate electrical signals by means of a potentiometer 29 coupled by means of pivot 26 to cylinder 23. Inside cylinder 23 is suspended from a transverse pivot point 30 a pendulum 31 adapted to swing in a plane passing through the centre of the weight 28 and point 30. Thus the angular position in degrees made by pendulum 31 with the longitudinal axis of cylinder 23 is continuously proportional to the angle of inclination of housing 10 and thus of the bore hole with the vertical as housing 10 is moved therethrough. Pendulum 31 is coupled by a rack and pinion gear 32 to a potentiometer 34 giving an electrical output that is continuously proportional to the angle which pendulum 31 makes with the longitudinal axis of the casing 10.

In order to prevent false indications from straight line movements, cylinder 23 is filled with liquid having approximately the same density as pendulum 31.

Potentiometers 22, 29 and 34 are connected (see Figure 4) through separate circuits to recording instruments laid at the surface of the earth, the whole of the device operating in a known manner to record the variations of resistance of said potentio-

meters. The device may cooperate, as indicated above, with a dipmeter such as the one described in the above-mentioned Letters Patent, and which has been diagrammatically shown in Fig. 4 by A, M, M', M".

What we claim is:—

1. An apparatus for determining the deviation of a bore-hole from the vertical axis and adapted to be moved inside said bore hole, which comprises a casing, compass means freely rotatably mounted in said casing for determining the position in azimuth of said casing with respect to a specified geographical direction, means for vibrating said compass means, a member freely pivotable about the longitudinal axis of said casing and carrying an off-centre weight adapted to cause said member to pivot about said axis in dependence upon the direction in azimuth of the deviation of the borehole, pendulum means on said member responsive to the angle of deviation of the bore hole from the vertical, and a circuit control member operatively connected to each of said compass means, said pivotable member and said pendulum means and responsive to movements of its associated element, each circuit control member being connectable in an electric circuit including indicating or recording instruments, preferably at the surface of the earth, responsive to variation of electrical magnitudes the value of which depends upon the angles of movement of said elements.

2. Apparatus as claimed in Claim 1, wherein the compass means comprise a compass mount universally suspended from a suspension mounted in the casing, and a bar magnet suspended in said mount, the interior of said mount being filled with a liquid having a density approximately equal to that of the bar magnet

3. Apparatus as claimed in Claim 1 and 2, wherein the vibrating means comprise an electric motor driving an eccentric adapted to bear upon and vibrate a shaft connected to the compass suspension.

4. Apparatus as claimed in Claim 1 to 3, wherein the circuit control member for the compass means comprises a potentiometer coupled to the bar magnet.

5. Apparatus as claimed in Claim 1, wherein said pivotable member comprises a hollow cylinder carrying the off-centre weight internally thereof.

6. Apparatus as claimed in Claims 1 and 5, wherein the circuit control member for the pivotable member comprises a potentiometer coupled to the cylinder.

7. Apparatus as claimed in Claims 1 and 5, wherein the pendulum means is suspended internally of the cylinder about a transverse pivot to swing in a plane passing through the centre of the off-centre weight and said pivot, the interior of said cylinder being filled with a liquid having a density approximately equal to that of the pendulum.

8. Apparatus as claimed in Claims 1 and 7, wherein the circuit control member for the pendulum means comprises a potentiometer coupled to the pendulum through a rack and pinion gear.

9. The apparatus for determining the deviation of a bore hole from the vertical axis constructed arranged and adapted to operate, substantially as herein-described and with reference to the accompanying drawings.

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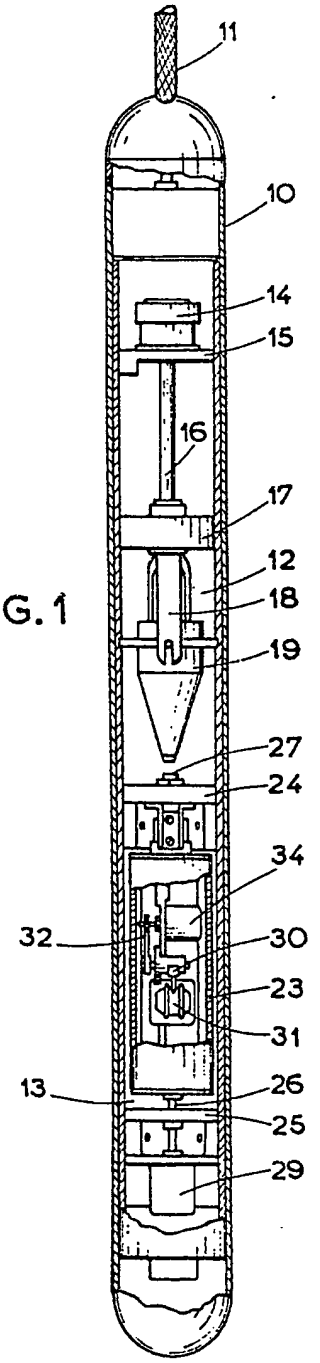

FIG. 1

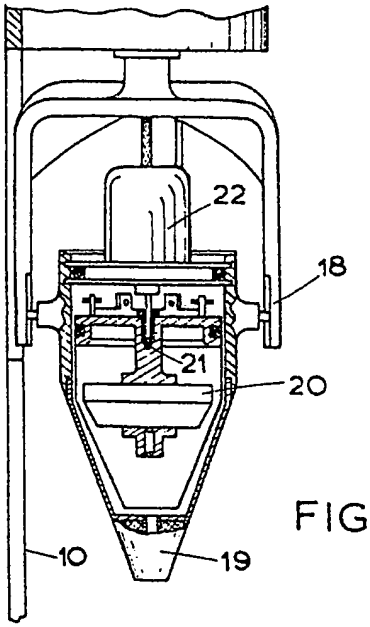

FIG. 2

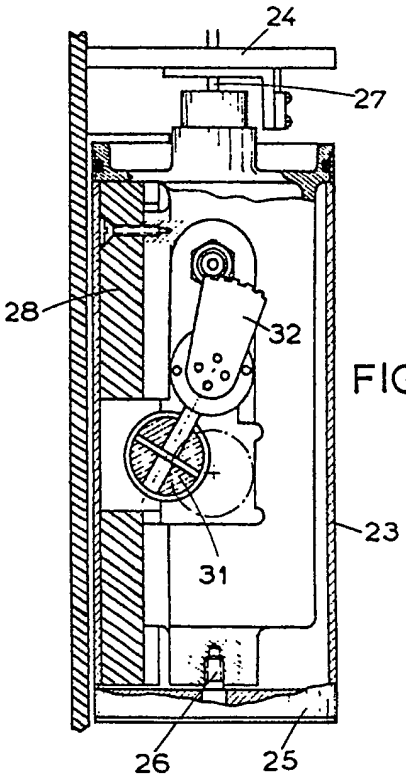

FIG. 3

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SHEETS 1 & 2

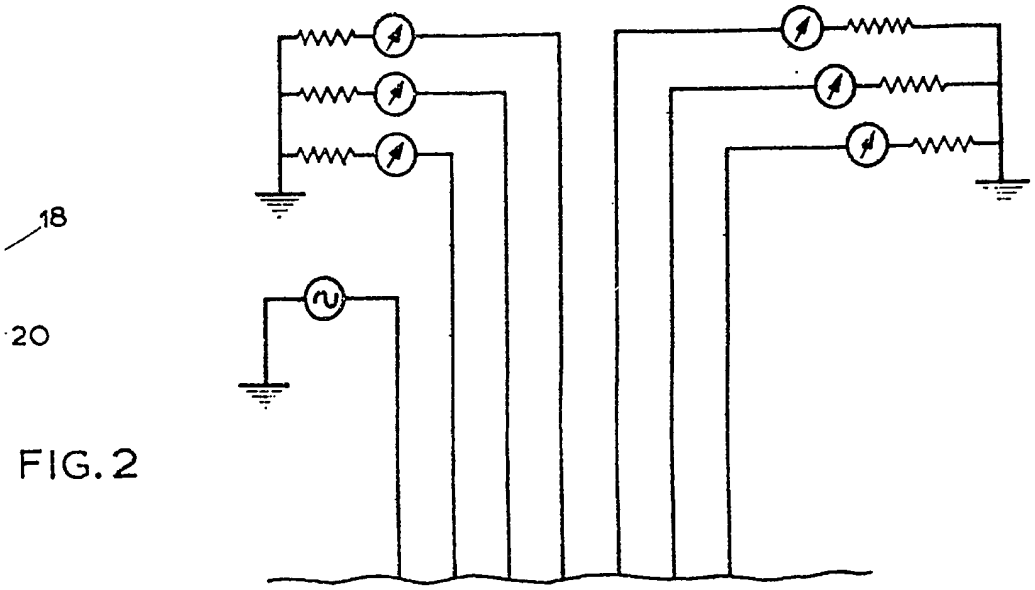

FIG. 2

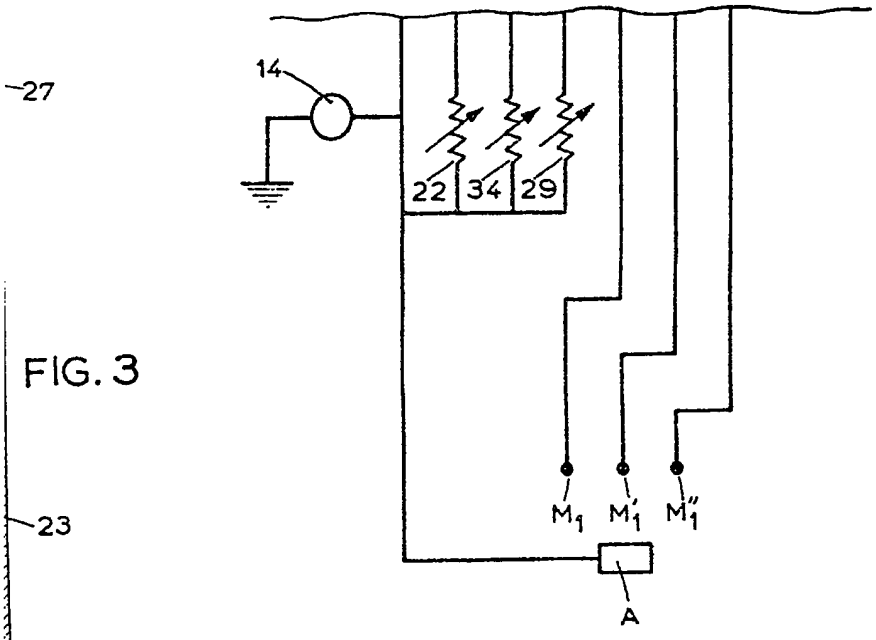

FIG. 3

FIG. 4

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SHEETS 1 & 2

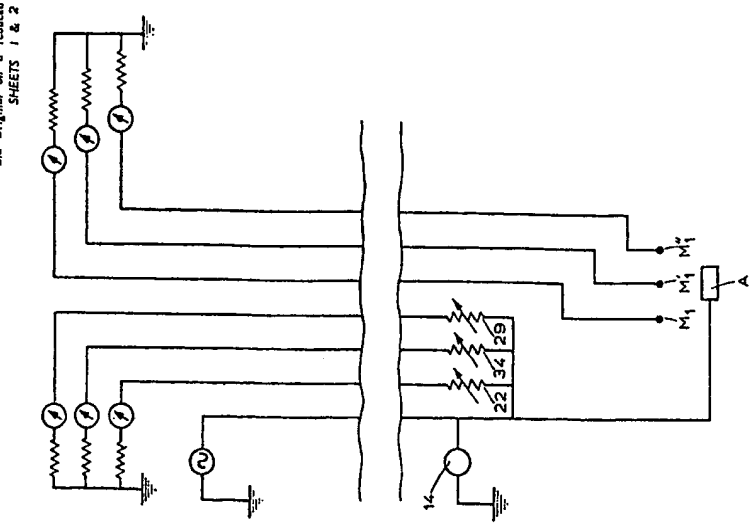

FIG. 4

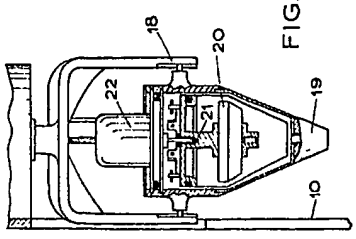

FIG. 2

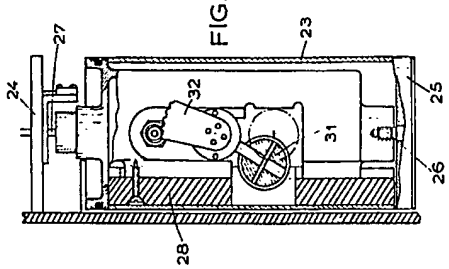

FIG. 3

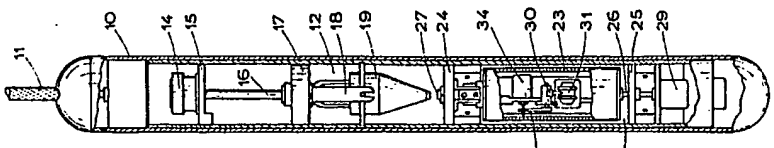

FIG. 1